(ANL-IN-02-081)

What Is Claimed Is:

1. An electrode material comprising compositions of $\text{Li}_{1+x}\text{Ni}_{\alpha}\text{Mn}_{\beta}A_{\gamma}O_{2}$ wherein A is chosen from the group consisting of Mg, Zn, Al, Co, Ga, B, Zr, Ti and further wherein x is between about 0 and 0.2, α is between about 0.1 and 0.5, β is between about 0.4 and 0.6, and γ is between about 0 and about 0.1.

- 2. The electrode material of claim 1, comprising a composition of $\text{Li}_{1+x}\text{Ni}_{\alpha}\text{Mn}_{\beta}\text{O}_2$, wherein x is between about 0 and 0.2, α is between about 0.2 and 0.5, and β is between about 0.5 and 0.6.
- 3. The electrode material of claim 1, wherein A is Mg and further wherein x is between about 0 and 0.2, α is between about 0.1 and 0.5, β between about 0.4 and 0.6, and γ is between about 0.01 and about 0.1.
- 4. The electrode material of claim 1, wherein A is Al and further wherein x is between about 0 and 0.2, α is between about 0.15 and 0.5, β is between about 0.45 and 0.6, and γ is between about 0.01 and about 0.1.
- 5. The electrode material of claim 1, wherein A is Co and further wherein x is between about 0 and 0.2, α is between about 0.15 and 0.5, β is between about 0.45 and 0.6, and γ is between about 0.01 and about 0.1.
- 6. The electrode material of claim 1, wherein A is Ti and further wherein x is between about 0 and 0.2, α is between about 0.2 and 0.5, the β is between about 0.4 and 0.6, and γ is between about 0.01 and about 0.1.
- 7. The electrode material of claim 1, wherein the material is manufactured by a solid state reaction method.
- 8. The electrode material of claim 7, wherein the materials are prepared by the steps of:

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mixing amounts of lithium hydroxide (or lithium carbonate), (Ni,Mn)-hydroxide, and A-hydroxide or A oxide (wherein A is chosen from the group consisting of Mg, Zn, Al, Co, Ga, B, Zr, and Ti) in acetone using zirconia balls for about 12-24 hours to form a mixed powder;

calcining the mixed powder at about 450~550°C for about 12-30 hours in air; calcining the mixed powder at about 900-1100°C for about 10-24 hours either in air or an nitrogen-oxygen atmosphere; and

quenching the calcined powders into liquid nitrogen.

- 9. The electrode material of claim 1, wherein the material is manufactured by an aqueous solution based process.
- 10. The electrode material of claim 9, wherein the materials are prepared by the steps of:

dissolving appropriate amounts of lithium hydroxide, nickel hydroxide, and A-hydroxide or A-nitrate (wherein A is chosen from the group consisting of Mg, Zn, Al, Co, and Ga) in distilled water whose pH is adjusted with nitric acid;

adding an aqueous solution of manganese acetate to form a mixed solution; refluxing the mixed solution in a round bottom flask attached with a condenser at about 80°C for about 12-24 hours;

evaporating the mixed solution in a rotary vacuum evaporator;

eliminating the organic contents in the mixed solution at about 400°C for about 2 hours:

calcining the resulting powder at about 900-1100°C for about 10-24 hours in either air or an nitrogen-oxygen atmosphere; and

quenching the resulting powder into liquid nitrogen.

11. The electrode material of claim 1, wherein the material is manufactured by a solgel method.

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12. The electrode material of claim 11, wherein the materials are prepared by the steps of:

dissolving appropriate amounts of lithium acetate, nickel acetate, manganese acetate, A-acetate or A-nitrate (wherein A is chosen from the group consisting of Mg, Zn, Al, Co, and Ga) in distilled water;

adding a glycolic/tartaric acid solution for use as a chelating agent; adjusting the pH of the resulting solution to about 7 to about 8 using ammonium hydroxide;

continuously stirring and heating the solution on a hot plate to form a gel precursor;

decomposing the gel precursor at 450°C about for about 5h in air to form a decomposed powder;

firing the decomposed powders at about 900-1100°C for about 10-24 hours in either an air or an nitrogen-oxygen atmosphere; and

rapidly quenching the calcined powders into liquid nitrogen.

- 13. The electrode material of claim 1, wherein the electrode material is a cathode.
- 14. A method for forming an electrode material made of substituted lithium nickel-manganese oxides, comprising the steps of: producing compositions of $\text{Li}_{1+x}\text{Ni}_{\alpha}\text{Mn}_{\beta}A_{\gamma}\text{O}_{2}$ wherein A is chosen from the group consisting of Mg, Zn, Al, Co, Ga, B, Zr, and Ti, and further wherein x is between about 0 and 0.2, α is between about 0.1 and 0.5, β between about 0.4 and 0.6, and γ between about 0 and about 0.1 through a electrode forming process chosen from the group consisting of a solid-state reaction method, an aqueous solution method, and a sol-gel method.
- 15. The method of claim 14, wherein the method of synthesis is the solid-state reaction method comprising the steps of:

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mixing amounts of lithium hydroxide (or lithium carbonate), (Ni,Mn)-hydroxide, and A-hydroxide or A oxide (wherein A is chosen from the group consisting of Mg, Zn, Al, Co, Ga, B, Zr, and Ti) in acetone using zirconia balls for about 12-24 hours to form a mixed powder;

calcining the mixed powder at about 450~550°C for about 12-30 hours in air; calcining the mixed powder at about 900-1100°C for about 10-24 hours either in an air or an nitrogen/oxygen atmosphere; and

rapidly quenching the calcined powders into liquid nitrogen.

16. The method of claim 14, wherein the method of synthesis is the aqueous solution method comprising the steps of:

dissolving appropriate amounts of lithium hydroxide, nickel hydroxide, and A-hydroxide or A-nitrate (wherein A is chosen from the group consisting of Mg, Zn, Al, Co, and Ga) in water;

adding an aqueous solution of manganese acetate to form a mixed solution; refluxing the mixed solution in a round bottom flask attached with a condenser at about 80°C for about 12-24 hours;

evaporating the mixed solution in a rotary vacuum evaporator;

eliminating the organic contents in the mixed solution at about 400°C for about 2 hours;

calcining the resulting powder at about 900-1100°C for about 10-24 hours in either an air or an nitrogen/oxygen atmosphere; and

rapidly quenching the calcined powders into liquid nitrogen.

17. The method of claim 14, wherein the method of synthesis is the sol-gel method comprising the steps of:

dissolving appropriate amounts of lithium acetate, nickel acetate, manganese acetate, A-acetate or A-nitrate; (wherein A is chosen from the group consisting of Mg, Zn, Al, Co, and Ga) in water;

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adding a glycolic/tartaric acid solution for use as a chelating agent; adjusting the pH of the resulting solution to about 7 to about 8 using ammonium hydroxide;

continuously stirring and heating the solution on a hot plate to form a gel precursor;

decomposing the gel precursor at 450°C about for about 5h in air to form a decomposed powder;

calcining the decomposed powders at about 900-1100°C for about 10-24 hours in either an air or an nitrogen/oxygen atmosphere; and

rapidly quenching the calcined powders into liquid nitrogen.

18. An electronic device comprising:

an electrode comprised of an electrode material having the formula $\text{Li}_{1+x}\text{Ni}_{\alpha}\text{Mn}_{\beta}\text{A}_{\gamma}\text{O}_{2}$ wherein A is chosen from the group consisting of Mg, Zn, Al, Co, Ga, B, Zr, and Ti and further wherein x is between about 0 and about 0.2, α is between about 0.1 and about 0.5, β is between about 0.4 and about 0.6, and γ is between about 0 and about 0.1.

- 19. The electronic device of claim 18, wherein the electronic device comprises a rechargeable battery.
- 20. The electronic device of claim 18, wherein the electrode is a cathode comprising a mixture of about 80 wt.% of the electrode material, about 10 wt.% carbon, and about 10 wt.% Polyvinylidene fluoride as a binder.